The neural basis of sentence comprehension of two languages in Korean-English late bilinguals

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Abstract

Fourteen Korean-English bilingual subjects were volunteered in our study with using functional MRI for investigating neural mechanisms underlying processing of these two different languages. The comparison of the activated cortical areas was carried out during the semantic judgment of visually presented sentences in L1 (Korean) and L2 (English). The results indicate that the temporal region was more involved in L1 processing, whereas the more frontal region activity was to see in L2 processing. On the basis of the result, we would suggest that the neural mechanisms of processing L1 and L2 should be different in terms of semantic judgment task.

Introduction

It is still debated if the processing between the first and second language is underlying similar neural mechanisms or not. There are some evidences that the cortical regions for the processing of native language (L1) and the second language (L2) are identical, whereas contradictory results indicate different cerebral activities between the processing of these two languages. Therefore, it should make senses to compare these two languages in terms of different levels of linguistic processing, especially the processing of sentences. Regarding the sentence processing, recent studies with using functional imaging technique such as fMRI or PET of syntactic and lexico-semantic processing indicate different results in case of cortical activity (left prefrontal cortex [Homae et al, 2002] or superior-temporal region [Kuperberg et al., 2000]. These two counterparts might be attributable to the difference of the various kinds of languages. Bilingual brain representation could provide a good suggestion on the processing of the linguistic aspects.

Methods

We applied fMRI to examine the bilingual brain activation at semantic aspects of sentence processing, in order to compare our previous study on syntactic processing (Lee S. et al. 2003). Fourteen right-handed Korean-English bilingual students participated in this study, who were moderately fluent in English but had not stayed more than 2 years in an English-speaking country. In the semantic decision task, the visually presented sentences(half of them violated the selection restriction rule, the other half were correct sentences) were judged based on the semantic appropriateness. The cortical activations were compared with the control task, which was ordering judgment task with the sentences of the same length. Before the experiment in the MR scanner, the participants were familiarized with the task paradigm. Visual sentences were produced using the E-prime. In each L1 and L2 session five blocks were repeated, and a block was comprised of the sentence task (36 sec.), the control task (36 sec.), and the rest (36 sec.). Images were acquired using 3 Tesla scanner(ISOL, Korea). Following a T1-weignted scout image, the high-resolution anatomic images were acquired using an MPRAGE sequence (TE= 35ms, TR= 3000ms, flip angle= 80^{o}, and image size of 64*64, Field of View=220*220). 30 slices with slice thickness of 4mm and no gaps in between for the whole brain. The images of each subject were realigned, coregistered, and normalized using the SPM99. Finally, the images were smoothed using a 7 mm full-width, half-maximum (FWHM) gaussian filter. Condition and subject effects were estimated using the general linear model at each voxel in brain space. Significant changes in hemodynamic response for each subject and condition were assessed using t-statistics. For the group analysis, single subject and condition were analyzed using a random effect model. Activations were reported if they exceeded a threshold $P < 0.001$ uncorrected on the single voxel level and on an extent level of ten voxels..

Results and Discussion

As a result to the processing of Korean sentences, the left inferior frontal gyrus, the bilateral lingual gyrus, the left cuneus, and the left superior and middle temporal gyrus were activated. While doing the tasks in English, the activated areas were observed at the left inferior frontal gyrus, the left medial frontal gyrus, the left lingual gyrus and the left cuneus. According to these results some overlapping regions in frontal and occipital regions can be observed. However, it is worth noting that the superior and middle temporal gyrus were activated only in Korean (L1). The frontal region was more activated in English (L2). We (Lee S. et al, 2003) have found the same result in the syntactic judgment task. Both of the previous and present results suggest that the L1 processing was more involved in the temporal region and L2 in frontal region. Further studies on bilingualism would be focused on these two regions to examine whether the acquisition age difference really exists or not.

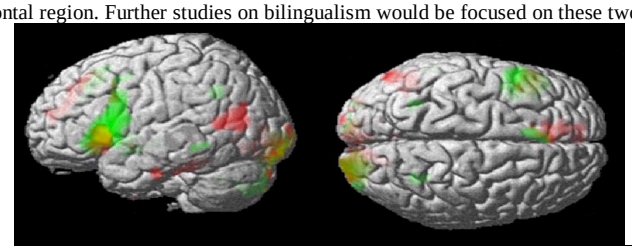

Fig.1. The activation areas in the semantic judgment task: red blots(Korean, L1), green blots(English, L2)

L1(Korean)			L2(English)		
x,y,z(mm)	Z-value	cortical areas(BA)	x,y,z(mm)	Z-value	cortical areas(BA)
-42, 19, 1	4.76	L. inf. frontal gyrus(47)	28, -92, -6	5.04	R. inf. occipital gyrus(18)
-53, 19, 1	4.27	L. inf. frontal gyrus(47)	-51, 18, 16	5.33	L. inf. frontal gyrus(45)
12, -91, 1	5.26	R. lingual gyrus(17)	-12, -97, -4	4.14	L. lingual gyrus(18)
22, -101, 5	4.71	R. mid-occip. gyrus(18)	-2, 31, 35	3.93	L. medial front. gyrus(6)
-48, -54, 12	4.39	L. sup. Temp. gyrus(39)	-6, 36, 24	3.16	L. ant. cingulate(32)
-50, -69, 11	3.77	L. mid temp. gyrus(39)	-14, 4, 0	3.85	L. Lentiform nucleus
-51, -65, 18	3.7	L. mid.temp.gyrus(39)	14, 8, -4	3.72	putamen
-16, -100, 11	3.91	L. cuneus(18)			
-16, -78, -5	3.5	L. lingual gyrus(18)			
-4, -66, 3	3.68	L. lingual gyrus(18)			

Tab.1. The activation areas in the semantic judgment task in L1 and L2

References

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